Chapter 1: Executive Summary

Climate change represents one of the greatest challenges of our time, with profound and wide-ranging implications for development, economic growth, the environment, and international security. The United States is committed to continuing enhanced action, together with the global community, to lead the global effort to achieve a low-emission, climate resilient future. This 2014 *U.S. National Communication* describes actions the United States is taking to confront climate change and prepare for its impacts. The report highlights major federal, state, and local initiatives and outlines U.S. efforts to assist other countries in addressing climate change.

National Circumstances

Chapter 2 of this report outlines the national circumstances of the United States and how they affect U.S. greenhouse gas (GHG) emissions. The United States is a large country with a diverse geography. The nation stretches across seven time zones, from the Atlantic seaboard to the Hawaiian Islands, and encompasses a full range of tropical, temperate, and Arctic ecosystems. The total U.S. land area is 3,548,112 square miles (9,192,000 square kilometers); about 28 percent of this land is owned and managed by the federal government in a system of parks, forests, wilderness areas, wildlife refuges, and other public lands.

The United States is a federal republic, whose government is divided into three distinct branches: executive, legislative, and judicial. Each branch plays a separate, significant role in the creation, implementation, and adjudication of America's laws, which includes shaping laws and policies related to climate change. In addition, the governments of U.S. states and localities have broad jurisdiction for energy regulation and land-use policy, and their laws and policies collectively have a substantial influence on the U.S. response to climate change.

As of 2013, the United States is the third most populous country in the world, with an estimated population of 316 million. From 1990 to 2008, the U.S. population grew by 54.5 million, at an average annual rate of just over 1 percent, for a total growth of approximately 22 percent since 1990. However, that growth has slowed somewhat since the global recession in 2008, with an average annual population growth rate of less than 1 percent in 2009, 2010, 2011, and 2012. Nevertheless, the growth rate of the U.S. population was still among the highest in the world among advanced economies during the last five years.

The U.S. economy is the largest national economy in the world, with a nominal gross domestic product (GDP) of $15.7 trillion in 2012, slightly smaller than the GDP of the European Union. The U.S. per capita GDP in 2012 was just over $49,600. Between 1990 and 2008, the U.S. economy grew by more than 60 percent (in constant 2005 dollars), one of the highest growth rates among advanced economies in this time frame. Between 2008 and 2013, however, the U.S. economy averaged only 0.6 percent in real annual GDP growth.

The United States is the world's second-largest producer and consumer of energy. The nation has large reserves of energy sources currently available for production, including fossil fuels, uranium ore, renewable biomass, and hydropower. Other renewable energy sources, such as solar and wind power, currently represent approximately 2 percent of the total energy resources used in the United States.

Several of the long-term trends identified in the 2010 Climate Action Report (CAR)—such as the historical pairing of economic growth and increased energy use—have slowed or reversed because of U.S. national circumstances. As economic growth has slowed since 2008, GHG emissions have also declined. Recent U.S. investments in energy efficiency have also been a factor in the continued decline in U.S. energy intensity. In the coming decades, U.S. energy intensity is projected to decline significantly, allowing the economy to grow while GHG emissions decline. Investments in renewable energy have led to rapid growth of wind, solar, and geothermal power in the energy mix. Solar power capacity grew by approximately 100 percent from 2008 through 2011, and wind power capacity grew by approximately 116 percent during that same period (U.S.DOE/EIA 2012).[1]

[1] U.S. DOE/EIA 2012, Table 8.2a. *See* http://www.eia.gov/totalenergy/data/annual/showtext.cfm?t=ptb0802a.

A major contributor to the decline in U.S. GHG emissions has been the displacement of coal with natural gas that is extracted from shale rock formations through hydraulic fracturing and horizontal drilling. The production of "shale gas" has grown rapidly in recent years. In 1996, U.S. shale gas wells produced 0.3 trillion cubic feet (8.5 billion cubic meters) of natural gas, representing 1.6 percent of U.S. gas production. By 2011, production of shale gas had increased to 8.5 trillion cubic feet (241 billion cubic meters) of natural gas, 30 percent of U.S. gas production. The extraction and use of shale gas are projected to continue to grow during the next several years.

The U.S. transportation system has evolved to meet the needs of a highly mobile, dispersed population and a large economy. Automobiles and light trucks still dominate the passenger transportation system, and the highway share of passenger miles traveled. In 2013, the most recent year of available data, automobiles and light trucks constituted about 87 percent of the passenger miles traveled, down 2 percentage points from the highway share listed in the 2010 CAR. Air travel accounted for slightly more than 11 percent (up 1.5 percentage points from the 2010 CAR), and mass transit and rail travel combined accounted for only about 1 percent of passenger miles traveled.

Greenhouse Gas Inventory

Chapter 3 summarizes U.S. anthropogenic GHG emission trends from 1990 through 2011. The estimates presented in the report were calculated using methodologies consistent with those recommended by the Intergovernmental Panel on Climate Change. A complete accounting of GHGs in the United States is referenced in Chapter 3 of this report in Figure 3-1 and Table 3-1. In 2011, total U.S. GHG emissions were 6,702.3 teragrams (Tg) of carbon dioxide equivalents (CO_2e). Overall, total U.S. emissions rose by 8 percent from 1990 through 2011. Over that same period, the U.S. GDP increased by 66 percent and population increased by 25 percent. CO_2 emissions accounted for approximately 84 percent of total U.S. GHG emissions in 2011.

As the largest source of U.S. GHG emissions, CO_2 from fossil fuel combustion has accounted for approximately 78 percent of global warming potential-weighted emissions since 1990. Emissions of CO_2 from fossil fuel combustion increased at an average annual rate of 0.5 percent from 1990 through 2011. The fundamental factors influencing this trend include (1) a generally growing domestic economy over the last 22 years, and (2) an overall growth in emissions from electricity generation and transportation activities. Between 1990 and the end of 2011, CO_2 emissions from fossil fuel combustion increased from 4,748.5 Tg CO_2e to 5,277.2 Tg CO_2e, an 11 percent total increase over the 22-year period. Historically, changes in emissions from fossil fuel combustion have been the dominant factor affecting U.S. emission trends.

Methane (CH_4) accounted for approximately 9 percent of total U.S. GHG emissions in 2011, with natural gas systems being the largest source of CH_4 emissions. U.S. emissions of CH_4 declined by 8 percent from 1990 through 2011. This decline was mostly due to both a decrease in emissions from natural gas transmission and storage resulting from increased voluntary reductions, and a decrease in natural gas distribution emissions resulting from a reduction in cast iron and unprotected steel pipelines, as well as an increase in the collection and combustion of landfill gas.

Nitrous oxide (N_2O) accounted for approximately 5 percent of total U.S. GHG emissions in 2011. The main U.S. human activities producing N_2O are agricultural soil management and stationary fuel combustion. Overall, U.S. emissions of N_2O increased by 4 percent from 1990 through 2011, largely due to the overall increase in N_2O emissions from agricultural soils. However, annual N_2O emissions from agricultural soils fluctuated between 1990 and 2011, largely as a reflection of annual variation in weather patterns, synthetic fertilizer use, and crop production.

Fluorinated substances—hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6)—accounted for 2 percent of total U.S. GHG emissions in 2011. The increasing use of these compounds since 1995 as substitutes for ozone-depleting substances (ODS) has been largely responsible for their upward emission trends.

Net CO_2 sequestration from land use, land-use change, and forestry (LULUCF) increased by 110.5 Tg CO_2e (14 percent) from 1990 through 2011. This increase was primarily due to growth in the rate of net carbon accumulation in forest carbon stocks, particularly in above-ground and below-ground tree biomass.

Policies and Measures

Chapter 4 of this report outlines approximately 100 near-term policies and measures undertaken by the U.S. government to mitigate GHG emissions. These policies and measures promote increased investment in end-use efficiency, clean energy development, and reductions in agricultural GHG emissions. The U.S. government is also working to reduce emissions from the most potent GHGs, with more than a dozen initiatives across five executive agencies targeting CH_4, N_2O, HFCs, PFCs, SF_6, and other fluorinated gases.

A large number of U.S. states and localities are implementing clean energy incentives and clean energy targets as well. These actions range from voluntary emission goals and green building standards to mandatory cap-and-trade laws.

In May 2010, the U.S. Environmental Protection Agency (EPA) issued a regulation establishing a common-sense approach to permitting GHG emissions. As of July 2013, EPA and states have issued nearly 102 permits to large industrial sources that cover GHG emissions.

On April 17, 2012, EPA issued cost-effective regulations to reduce harmful air pollution from the oil and natural gas industry, while allowing continued, responsible growth in U.S. oil and natural gas production. These regulatory standards achieve a significant co-benefit of CH_4 emission reductions, estimated at 32.6 Tg CO_2e in 2015 and 39.9 Tg CO_2e in 2020.

The National Program for Light-Duty Vehicle GHG Emission Standards and Corporate Average Fuel Economy Standards for combined model years (MYs) 2012–2025 will effectively cut in half vehicle GHG emissions, reducing 6,000 Tg CO_2e over the lifetimes of the vehicles sold in MYs 2012-2025. Similarly, the National Program for Heavy-Duty Vehicle GHG Emission Standards and Fuel Efficiency Standards for MYs 2014–2018 will significantly reduce GHG emissions and fuel consumption from heavy-duty vehicles. The heavy-duty vehicle program will cut GHGs by 270 Tg CO_2e during the lifetimes of the vehicles sold in MYs 2014–2018.

New lighting energy efficiency standards will result in the phasing out the 130-year-old incandescent light bulb by the middle of the next decade and phases out less efficient fluorescent tubes. The new standards are estimated to have a GHG mitigation potential of 36.3 Tg CO_2e in 2015 and 37.7 Tg CO_2e in 2020.

Projected Greenhouse Gas Emissions

Chapter 5 provides projections of U.S. GHG emissions through 2030, including the effects of policies and measures in effect as of September 2012, the cutoff date for the *Annual Energy Outlook's* baseline projections of energy-related CO_2 emissions. The "with measures" scenario presented in this 2014 National Communication does not include the impacts of more recent policies, including the President's June 2013 *Climate Action Plan*, which are presented in the Biennial Report that comprises a part of the U.S. Climate Action Report. (EOP 2013).

The projections of U.S. GHG emissions described here reflect national estimates considering population growth, long-term economic growth potential, historic rates of technology improvement, and normal weather patterns. They are based on anticipated trends in technology deployment and adoption, demand-side efficiency gains, fuel switching, and many of the implemented policies and measures discussed in Chapter 4.

Projections are provided in total, by gas and by sector. Gases included in this report are CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6. Sectors reported include energy (subdivided into electric power, residential, commercial, and industrial); transportation; industrial processes; agriculture; waste; and LULUCF. For the LULUCF sector, projections through 2030 are presented as a range based on two alternative scenarios, while a text box describes longer-term trends in the sector.

Given implementation of programs and measures in place as of September 2012 and current economic projections, total gross U.S. GHG emissions are projected to be 4.6 percent lower than 2005 levels in 2020. Between 2005 and 2011 total gross U.S. GHG emissions have declined significantly due a combination of factors, including the economic downturn and fuel switching from coal to natural gas (U.S. EPA 2013). Emissions are projected to rise gradually between 2011 and 2020. Emissions are projected to remain below the 2005 level through 2030, despite significant increases in population (26 percent) and GDP (69 percent) during that time period. More rapid improvements in technologies that emit fewer GHGs, new GHG mitigation requirements, or more rapid adoption of voluntary GHG emission reduction programs could result in lower gross GHG emission levels than in the "with measures" projection.

Between 2005 and 2020, CO_2 emissions in the "with measures" projection (measures in place as of 2012) are estimated to decline by 7.5 percent. In contrast, in the 2010 CAR, CO_2 emissions were expected to *increase* by 1.5 percent between 2005 and 2020 (U.S. DOS 2010), a change of about 9 percent, and in the 2006 CAR, emissions were expected to increase by 14 percent between 2004 and 2020 (U.S. DOS 2006). During the same period, CH_4 and N_2O emissions are expected to grow by 3.5 percent and 6.1 percent, respectively. The most rapid growth is expected in fluorinated GHGs (HFCs, PFCs, and SF_6) which are expected to increase by more than 60 percent between 2005 and 2020, driven by increasing use of HFCs as substitutes for ODS.

Impacts and Adaptation

Chapter 6 of this report highlights actions taken in the United States to better understand and respond to vulnerabilities and impacts associated with climate change. All levels of government are working together on an array of climate assessments, research, and other activities to understand the potential impacts of climate change on the environment and the economy and to develop methods and tools to enhance adaptation options.

Notably during this reporting period, the United States undertook development of the Third National Climate Assessment (NCA), as mandated by the Global Change Research Act of 1990 (GCRA) (NCADAC 2013). The NCA brings together the best peer-reviewed science on climate change and its impacts on the United States, leveraging research across regions and sectors and providing a basis for future assessment and action. The draft Third NCA was developed through a transparent process that included more than 1,000 direct contributors and 240 chapter authors from academia, resource management agencies, and nongovernmental organizations (NGOs), in addition to government scientists. The U.S. government also sponsors some of the world's most advanced scientific research on climate change. The U.S. Global Change Research Program (USGCRP), also established by the GCRA, is designed to coordinate the federal government's $2.6 billion annual investment in global change research.

Chapter 6 describes:

- Climate and global change impacts on the United States;
- Observed and projected regional, sectoral, and cross-cutting vulnerabilities, such as the potential for water scarcity, interruptions in energy production and transmission, and disruption of multimodal transportation systems;
- Continuing and planned research and sustained assessments to improve the understanding of impacts, vulnerabilities, and options for response over time; and
- Ongoing adaptation measures, including examples of adaptation actions taking place at multiple scales throughout the nation.

Through the creation of special programs related to climate adaptation, the U.S. government is working to address its vulnerabilities to both abrupt and more gradual changes in U.S. climate. At the direction of the Interagency Climate Change Adaptation Task Force, federal agencies have begun integrating adaptation planning into their operations, missions, and programs, with the first set of agency-specific adaptation plans publicly released in February 2013. At the recommendation of the task force, Congress, and other interagency bodies, federal agencies also developed a series of cross-cutting strategies to reduce the impacts of climate change on the nation's freshwater resources, ocean resources, and fish, wildlife, and plants. Chapter 6 includes examples of these efforts and discusses these strategies in detail.

States, tribes, and localities also have major roles to play in vulnerability assessment and adaptation, given that many decisions are made at the local level. Chapter 6 contains several examples of this work, such as New York City's development of customized heat-warning systems and California's implementation of building standards mandating energy and water efficiency savings.

Finally, the United States is committed to establishing and maintaining climate adaptation assistance for both domestic and international communities through the 2010 Presidential Policy Directive on Global Development's Global Climate Change Initiative (GCCI), the Climate Services Partnership, and other efforts of the U.S. Agency for International Development and the U.S. Department of State.

Financial Resources and Transfer of Technology

Chapter 7 outlines U.S. government initiatives and partnerships and U.S. agency roles in climate-related international assistance and technology transfer. This chapter of the 2014 National Communication provides detail on U.S. climate finance by channels and instruments, thematic pillar, and region. It also describes U.S. efforts to mobilize private climate finance, and illustrates examples of U.S. contributions to capacity building and transfer of technology.

Since the period covered by the 2010 CAR, climate change has become a major thrust of U.S. diplomatic and development assistance efforts. The 2010 Presidential Policy Directive on Global Development identified the GCCI as one of three priority U.S. development initiatives. The GCCI provides a platform upon which the United States builds climate change considerations into its foreign assistance operations. The 2010 *U.S. Quadrennial Diplomacy and Development Review* also identified climate change as one of the main pillars of U.S. diplomacy and international development (U.S. DOS and USAID 2010).

Through the GCCI and other enhanced climate-related investments, the United States has significantly ramped up its provision of climate finance and is assisting dozens of developing countries to mitigate and adapt to climate change. The United States is using the full range of mechanisms—bilateral, multilateral, and private finance—to invest strategically in building lasting resilience to unavoidable climate impacts; reducing emissions from deforestation and land degradation; and supporting low-carbon development strategies and the transition to a sustainable, clean energy economy. The nation is working hard to ensure that U.S. support is efficient, effective, innovative, based on country-owned plans, and focused on achieving measurable results, with a long-term view of economic and environmental sustainability.

As noted in the Doha Agreements, developed country Parties successfully achieved the "fast start" finance goal. The United States provided $7.5 billion during fiscal years 2010, 2011, and 2012 to more than 120 countries through bilateral and multilateral channels, meeting the President's commitment to provide our fair share of the collective pledge. This $7.5 billion consists of more than $4.7 billion of congressionally appropriated assistance and more than $2.7 from U.S. development finance and export credit agencies. The $4.7 billion in appropriated assistance levels represents a fourfold increase in annual climate assistance since 2009, with a ninefold increase in adaptation assistance.

Maintaining a strong core of public climate finance is essential, and the United States intends to maintain its commitment to climate change as an important component in the U.S. assistance budget. Private investment will inevitably play an increasingly important role as developing countries put mitigation and adaptation policies and actions into place. The nation is are working to combine its significant but finite public resources with targeted, smart policies to mobilize maximum private investment into climate-friendly activities. The United States is actively pursuing strategies to encourage private investment in low-carbon, climate-resilient activities in developing countries, and to support countries in their efforts to create a policy framework that will attract investment in clean energy and other climate-supportive activities. Continuing to execute this vision will be important as developed countries, including the United States, work toward a collective goal of mobilizing $100 billion per year in climate change finance for developing countries by 2020, in the context of meaningful mitigation actions and transparency on implementation.

The United States has also been working with its developed country partners to collectively develop and coordinate strategies for scaling up climate-friendly investment in developing countries. In April 2013, the United States held an inaugural meeting of climate ministers and senior officials from development and finance ministries to explore ways to coordinate more closely on the issue of how to use public resources and policies to mobilize the maximum amount of total investment in climate action. The developed countries in attendance agreed to focus on strengthening and augmenting key tools that are provided through existing public finance institutions that operate at the nexus with the private sector: development finance institutions, multilateral development banks, key multilateral climate change funds, and export credit agencies. The United States has been and will continue to play an active role internationally to help coordinate this work going forward.

Research and Systematic Observation

Chapter 8 describes how the United States is providing the fundamental scientific and technological foundation for understanding the causes and consequences of climate and global change, reducing scientific uncertainties, and supporting adaptation and mitigation actions aimed at managing risks and producing benefits at local, regional, and global scales. The chapter covers three broad areas: research on global change, systematic observations, and research and development of technologies to address climate change.

The United States has always placed a high priority on research to understand global change. U.S. federal agencies have put forward a coordinated set of investments in global change science to gain new theoretical knowledge of Earth system processes; to maintain and enhance a mix of atmospheric, oceanic, land, and space-based observing systems; to advance predictive capabilities through the next generation of numerical modeling; to promote advances in computational capabilities, data management, and information sharing; and to further develop an expert scientific workforce in the United States and worldwide. These include major investments under the American Recovery and Reinvestment Act (Recovery Act) to enhance research infrastructure, build next-generation cyberinfrastructure assets, and award many new research grants and graduate fellowships.

Over the past three years, the United States has enhanced coordination with other nations and international organizations on global change research activities, promoted increased international access to scientific data and information, and fostered increased participation in international global change research by developing nations.

All of these research and assessment activities depend on the existence of a comprehensive, continuous, integrated, and sustained set of physical, chemical, biological, and societal observations of global change and its impacts. These observations are essential for improving the understanding of the components and processes of the Earth system and the causes and consequences of global change. The United States supports a large number of remote-sensing satellite platforms, as well as a broad network of Earth-based global atmospheric, oceanic, and terrestrial observation systems that are essential to climate monitoring globally. These systems are a baseline Earth-observing system and include Earth-observing satellites and extensive nonsatellite observational capabilities across multiple federal agencies that participate in the USGCRP.

Over the last three years, the United States achieved new milestones with the launch of critical new satellite-observing systems, including the Suomi National Polar-orbiting Partnership, the Landsat Data Continuity Mission/Landsat-8, and Aquarius (in partnership with the Space Agency of Argentina). In addition, new surface-based networks, such as the National Ecological Observatory Network and the Ocean Observatories Initiative are well on their way to operation, creating a next generation of *in situ* observing capabilities. And the Atmospheric Radiation Measurement Climate Research Facility, through the U.S. Department of Energy (DOE) Office of Science, received $60 million in Recovery Act funding to enhance its climate change research capabilities, by deploying an expansive array of new instruments.

Finally, this chapter details how the U.S. government is supporting clean energy and climate change mitigation technologies. The technology research and innovation activities within all of these areas, which span multiple federal agencies, are organized around the goals of reducing emissions from energy supply, energy end use, and infrastructure; capturing and sequestering CO_2 emissions; reducing emissions of other GHGs; and measuring and monitoring emissions. They also include bolstering the contributions of basic science to the development of new technologies and monitoring systems. These efforts build on such initiatives as the creation of the DOE Advanced Research Projects Agency-Energy, to spur a revolution in clean energy technologies.

Education, Training, and Outreach

Chapter 9 outlines the expansion of U.S. climate change education, training, and outreach efforts since the 2010 CAR. Climate change communication faces many challenges, but federal agencies, civil society, and individuals have invested in numerous initiatives to establish a climate-literate citizenry. In the U.S. National Research Council report *America's Climate Choices*, the authors find that "climate change is difficult to communicate by its very nature." However, "education and communication are among the most powerful tools the nation has to bring hidden hazards to public attention, understanding, and action" (NRC 2011).

The United States is working to focus and evolve the use of these tools. Numerous federal, NGO, and individual efforts have supported sustained and robust educational and communications initiatives to develop a climate-literate citizenry and skilled workforce. These include initiatives in schools, online (e.g., Climate.gov), and in the workplace, among many others. When

citizens have knowledge of the causes, likelihood, and severity of climate impacts, as well as of the range, cost, and efficacy of options to adapt to impacts, they are more prepared to effectively address the risks and opportunities of climate change. Furthermore, since 2010, more Americans than ever before experienced the impacts of climate change first-hand in the form of extreme events, such as prolonged drought and stronger and more frequent wildfires, resulting in increased public interest and an opportunity for engagement on climate literacy issues.

U.S. federal agencies—including the U.S. Agency for International Development; the Departments of Agriculture, Commerce, Energy, the Interior, and Transportation; EPA; the National Aeronautics and Space Administration; National Oceanic and Atmospheric Administration; and the National Science Foundation—work on a wide range of climate change education, training, and outreach programs. A USGCRP Communication and Education Interagency Working Group was formed in 2008 to coordinate these efforts and develop an integrated national approach to climate change. Efforts by industry, states, local governments, universities, schools, and NGOs are essential complements to more than 100 federal programs that educate industry and the public regarding climate change. The combined efforts of the U.S. federal, state, and local governments and private entities are ensuring that the American public is able to understand and address climate change, in terms of both stabilizing and reducing emissions of GHGs, and also increasing capacity to adapt to the consequences of climate change.

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